



# DEVELOPMENT AND VALIDATION OF 21<sup>ST</sup> CENTURY SKILL INSTRUMENT IN PHYSICS

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## ABSTRACT

The study aimed to develop and validate 21st century skill instrument in Physics. According to NCREL, & Metiri Group (2003) 21<sup>st</sup> century skills are composed of digital literacy, inventive thinking, effective communication and high productivity. The Partnership of 21<sup>st</sup> century skills and enGauge 21<sup>st</sup> century skills models were utilized in the study. The researcher initially developed questions for four constructs namely digital literacy, inventive thinking, effective communication and high productivity. The developed instrument makes use of 4point Likert scale and had 45 questions. This instrument was validated by five experts in science education. For further validation, the instrument was administered to 143 senior high school students from Zambales, Philippines. Factor analysis resulted to five factors: a) information literacy, b) inventive thinking, c) effective communication, d) high productivity and e) leadership. It was found that the developed 21<sup>st</sup> century skill instrument in Physics has established internal consistency with an over-all Cronbach alpha value of 0.901. Each factor was also found to meet the requirements of internal consistency having gained a Cronbach alpha values of 0.798, 0.862, 0.810, 0.706 and 0.705 respectively. The validated 21<sup>st</sup> century skill instrument in Physics has 37 questions.

**KEYWORDS:** 21<sup>st</sup> century skill, General Physics, information literacy, inventive thinking, collaboration.

## INTRODUCTION:

21<sup>st</sup> century framework described the skills, knowledge and expertise students must gain to be prepared in the real world. Students must learn essential skills such as critical thinking, problem solving, communication and collaboration. (Basu & Barto, 2007). Furthermore according to Department of Education, Philippines K to 12 Curriculum Guide in Science, at the end of grade 12 the learner should have gained skills in obtaining scientific and technological information from varied sources about global issues that have impact on the country. They should have acquired attitudes that will allow them to innovate and create products useful to community or country. In addition, learners should have made plans related to their interests and expertise considering the needs of their community and country.

Hamilton, et.al (2013) enumerated the 21<sup>st</sup> century competencies: cognitive competencies, interpersonal competencies, and intrapersonal competencies. Cognitive competencies are academic mastery, critical thinking, and creativity. 21<sup>st</sup> century learners should gain mastery of the content, should be able to make correct analyses, inferences and evaluations, and should learn how to innovate. Interpersonal competencies refers to communication and collaboration, leadership and global awareness. Students should be able to communicate clear information, resolve conflict, make decision, solve problem and negotiate. Leadership skill is being able to initiate, build consensus, innovate new strategies, implement policies and program. In terms of global awareness, students are expected to understand the interrelatedness of people, institutions and systems. Intrapersonal competencies include growth mindset, learning how to learn, intrinsic motivation and grit. Students should see intelligence as malleable and as a function of effort, they should be able to know how to approach a problem or task, monitor his or her comprehension, and evaluate work progress. Students are also expected to show intrinsic motivation.

The Partnership of 21<sup>st</sup> Century Skills (2002) presented model of 21<sup>st</sup> century skills. It stated that 21<sup>st</sup> century learner must learn the following subjects and complementary skills; a) Core academic subjects including English, world languages, arts, Math, Economics, Science, Geography, History, government and civics, b) Interdisciplinary themes such as global awareness, financial, economic, business and entrepreneurial literacy and health literacy, learning and c) innovation skills including creativity, innovation, critical thinking, problem solving, communication and collaboration, d) information, media and technology skills and life and career skills.

According to NCREL, & Metiri Group. (2003) 21<sup>st</sup> century skills are composed of digital age literacy, inventive thinking, effective communication and high productivity (Soh, et.al, 2012). Digital literacy is being able to use digital technology, communications equipment and networks to access, consolidate, evaluate and create information. Inventive thinking has the following components: a) adaptability and managing complexity, self-direction, curiosity, creativity, risk taking, higher order thinking and sound reasoning. Effective communication involves teamwork and collaboration, interpersonal skills, social and civic responsibility, interactive communication. While high productivity is about prioritizing, planning and managing for results, effective use of real world tools and production of relevant and high quality products.

## OBJECTIVES OF THE STUDY:

The present study aimed to develop and validate a 21<sup>st</sup> century skill instrument in Physics. It aimed to establish internal consistency and construct validity of the instrument.

## SIGNIFICANCE OF THE STUDY:

Attainment of 21<sup>st</sup> century skills have been given emphasis in our present educational system. A validated instrument is necessary to measure if students have attained these skills in the course of their study. This study will help instructors assess the 21<sup>st</sup> century skills gained by students in a Physics class.

## METHODOLOGY:

### Sample of the study:

The developed instrument was subjected to face and content validity. Five experts in the field of Science education participated in the face and content validity. To further establish the instrument's validity and reliability, it was administered to 143 students. Respondents were from senior high schools from Zambales, Philippines. The respondents were taking General Physics 1 during the validation period. Cluster sampling was employed in the study.

### Design and validity of instrument:

Factors of 21<sup>st</sup> century skill were identified through intensive review of related literatures. The Partnership of 21<sup>st</sup> century skills (2002) and enGauge 21<sup>st</sup> century skills (2003) models were utilized in the study. After identifying the factors involved in the 21<sup>st</sup> century skills, individual items were written by the researcher. The instrument makes use of a 4point Likert scale. Five experts in the field of Science education participated in the face and content validity of the study. Experts are Science education graduate students of De La Salle University. After considering the revisions suggested by experts, construct validity was investigated through the use of principal component factor analysis with Promax rotation and Kaiser normalization. Each item was also investigated for its internal consistency. Cronbach alpha coefficient were identified for each item. To ensure the readability and comprehensibility of each item in the 21<sup>st</sup> century skill instrument in Physics, three students were subjected to focus group discussion.

### Statistical Treatment:

The researcher used factor analysis to identify the different components of 21<sup>st</sup> century skill instrument in Physics based on the current setting. The items to be retained were determined by factor loading based on cut-off values. The 0.4 cut-off values were considered applicable (Hair et.al, 2006). To establish the reliability of the instrument, each factor was investigated. Cronbach alpha coefficients were calculated in each construct for internal consistency analysis. Over-all internal consistency was also investigated.

## RESULTS AND DISCUSSION:

### Factor analysis results:

Data from 45 questions was subjected to principal axis factor analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.783. Bartlett's test is less than 0.001 ( $p < 0.001$ ) which is significant. This means that we will reject the null hypothesis that the correlation of the items is an identity matrix. The number of factors was determined using the total variance explained table and scree plot. The total variance explained table shows 13 factors with eigenvalue greater than

1 to explain 69.56% of the total variance but the scree plot only suggested five factors to explain 46.84% of the total variance. The pattern matrix from the output of factor analysis showed five factors having enough number of items. Extraction method used was Principal component analysis to establish five-factor solution. Rotation method used was Promax with Kaiser Normalization. Criterion of load-

ing was set to 0.40. Only 37 items were retained. Sample factor loadings are shown in table 1.

Five factors were identified a) Information literacy, b) Inventive thinking, c) Effective communication, d) High productivity and e) leadership.

**Table 1: Factor loadings of sample questions from 21<sup>st</sup> century skill instrument in Physics**

Questions	Factor loading
<b>INFORMATION LITERACY</b>	
1. I can learn new Physics concepts through surfing the internet.	0.666
2. I can organize Physics ideas or information from the internet.	0.777
3. I use available resources from the internet in order to understand better the Physics concepts that we have learned.	0.807
<b>INVENTIVE THINKING</b>	
1. I can generate ideas in Physics.	0.663
2. I can handle different tasks given to us.	0.576
3. I am able to design a Physics experiment.	0.767
4. I can compare variables in a Physics experiment.	0.554
<b>EFFECTIVE COMMUNICATION</b>	
1. During group activity, I listen to the opinion of others.	0.747
2. I am willing to make mistakes in a Physics class.	0.460
3. I am able to communicate my ideas in written reports.	0.505
4. I can manage my emotions when working in a group.	0.608
<b>HIGH PRODUCTIVITY</b>	
1. I can make informative report in Physics.	0.440
2. I can analyze and interpret experimental results.	0.445
3. I organize information to achieve the goal to a specific problem/	0.639
<b>LEADERSHIP</b>	
1. I can delegate tasks to my group mates.	0.638
2. I work effectively during group works.	0.607
3. I know how to prioritize tasks or assignments.	0.706

The first construct is information literacy. This describes the ability of students to use digital technology such as computers, internet, and web search engines in understanding Physics concepts. This describes their ability to choose appropriate technologies in studying Physics. Factor 2, Inventive thinking reflects students' creativity and ability to create products from the concepts they have learned. Questions in this factor also reflect students' ability to plan their own investigations in Physics class. The third factor, effective communication refers to students' ability to properly communicate their ideas with their group mates. High productivity refers to ability of students to organize to achieve their goals of specific problems and ability to develop relevant informational materials. The last factor is leadership showing students' ability to set goals and effectively work in groups.

#### Reliability of the Instrument:

Table 2 shows the results of reliability analysis of the 21<sup>st</sup> century skills instrument. Internal consistency is established as shown by the acceptable Cronbach alpha coefficients. The table shows acceptable values of Cronbach alpha coefficients. Over-all, the 21<sup>st</sup> century skill instrument in Physics has established its internal consistency with a Cronbach alpha value of 0.901.

**Table 2: Reliability Analysis of 21<sup>st</sup> century skills instrument in Physics using Cronbach Alpha Coefficient**

Construct (N=143)	Cronbach Alpha Coefficient ( $\alpha$ )
Information literacy	0.798
Inventive thinking	0.862
Effective communication	0.810
High productivity	0.706
Leadership	0.705
Overall	0.901

#### CONCLUSION AND RECOMMENDATIONS:

21<sup>st</sup> century skill instrument in Physics has been developed and validated. Five experts checked for the content validity of the instrument. It was also found to have established internal consistency with an over-all Cronbach alpha value of 0.901. Today's educational system has broadened its perspectives. Assessment is not confined to measuring students' concept attainment. Assessment is also after students' attainment of 21<sup>st</sup> century skills. Thus, this instrument can be used to measure if students have attained 21<sup>st</sup> century skills throughout their Physics

course. The 21<sup>st</sup> century skills which can be measured by this instrument are: a) information literacy, b) inventive thinking, c) effective communication, d) high productivity and e) leadership.

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